CLAIMS

1. A filter having an input electrode, an output electrode, and a single acoustic wave resonator disposed between said input electrode and said output electrode, formed on a substrate, said acoustic wave resonator having one resonance mode for use as a filter, wherein:

said filter has a number of structures capable of simultaneously and independently changing all parameters for determining frequency characteristics of said filter, said parameters including a center frequency of said acoustic wave resonator, an external Q-value between said acoustic wave resonator and said input electrode, and an external Q-value between said acoustic wave resonator and said output electrode, said structures being capable of being simultaneously applied with electric signals independently of one another, said number of structures being at least equal to the number of the parameters, and

said filter includes an electromechanical transducer having a function capable of mechanically deforming one portion of each of said structures of said filter simultaneously and with finite dependency by individually applying the electric signals to electrodes disposed in said structures, respectively.

2. A filter having an input electrode, an output electrode, and a resonator unit including at least one acoustic wave resonator disposed between said input electrode and said output electrode and comprising a plurality of acoustic wave resonance modes for use as a filter within said acoustic wave resonator, said input electrode, said output electrode, and said resonator unit being formed on a substrate, wherein:

said filter has a number of structures capable of simultaneously and

independently changing all parameters for determining frequency characteristics of said filter, said parameters including a coupling coefficient between the plurality of resonance modes of said resonator unit, a center frequency, an external Q-value between said acoustic wave resonator and said input electrode, and an external Q-value between said acoustic wave resonator and said output electrode, said structures being capable of being simultaneously applied with electric signals independently of one another, said number of structures being at least equal to the number of the parameters, and

said filter includes an electromechanical transducer having a function capable of mechanically deforming one portion of each of said structures of said filter simultaneously and with finite dependency by individually applying the electric signals to electrodes disposed in said structures, respectively.

3. The filter according to claim 1, wherein said electromechanical transducer is a mechanism which is capable of mechanically deforming a portion of each of said structures of said filter through an electrostatic force or through deformation of a piezoelectric material by applying the electric signal.

4. The filter according to claim 2, wherein said electromechanical transducer is a mechanism which is capable of mechanically deforming a portion of each of said structures of said filter through an electrostatic force or through deformation of a piezoelectric material by applying the electric signal.

5. The filter according to claim 3, wherein end faces of said acoustic wave resonator are opposite to an end face of said input electrode and an end face of said output electrode across predetermined gaps, and said filter includes, as said electromechanical transducer, a mechanism for changing the distances between the end faces of said acoustic wave resonator and the end faces of said input electrode and said output electrode, or areas of the end faces that are opposite to each other through an electrostatic force or through deformation of a piezoelectric material.

6. The filter according to claim 4, wherein end faces of said acoustic wave resonator are opposite to an end face of said input electrode and an end face of said output electrode across predetermined gaps, and said filter includes, as said electromechanical transducer, a mechanism for changing the distances between the end faces of said acoustic wave resonator and the end faces of said input electrode and said output electrode, or areas of the end faces that are opposite to each other through an electrostatic force or through deformation of a piezoelectric material.

7. The filter according to claim 3, including, as said electromechanical transducer, a mechanism for mechanically deforming a portion of said acoustic wave resonator through an electrostatic force or through deformation of the piezoelectric material.

8. The filter according to claim 4, including, as said electromechanical transducer, a mechanism for mechanically deforming a portion of said acoustic wave resonator through an electrostatic force or through

deformation of the piezoelectric material.

9. The filter according to claim 7, wherein said electromechanical transducer is a mechanism which changes a tension applied to said acoustic wave resonator with a mechanical deformation of a portion of said acoustic wave resonator.

10. The filter according to claim 8, wherein said electromechanical transducer is a mechanism which changes a tension applied to said acoustic wave resonator with a mechanical deformation of a portion of said acoustic wave resonator.

11. The filter according to claim 1, wherein said input electrode, said acoustic wave resonator, and said output electrode are formed of a semiconductor or a metal or an insulating material having a surface covered with a semiconductor or a metal.

12. The filter according to claim 2, wherein said input electrode, said acoustic wave resonator, and said output electrode are formed of a semiconductor or a metal or an insulating material having a surface covered with a semiconductor or a metal.

13. The filter according to claim 1, wherein a local oscillator is connected to at least one of said input electrode or said acoustic wave resonator or said output electrode.

14. The filter according to claim 2, wherein a local oscillator is connected to at least one of said input electrode or said acoustic wave resonator or said output electrode.

15. The filter according to claim 1, comprising a storage circuit for storing values corresponding to the electric signals which realize the center frequency and the external Q-value of said acoustic wave resonator compatible with desired frequency characteristics, and an applied voltage generator for reading a stored value from said storage circuit, converting the stored value to the electric signal, and delivering the electric signal,

wherein the electric signal delivered by said applied voltage generator is used as an input signal to said electromechanical transducer.

16. The filter according to claim 2, comprising a storage circuit for storing values corresponding to the electric signals which realize a coupling coefficient between resonance modes, the external Q-value, and the center frequency of said resonator unit compatible with desired frequency characteristics, and an applied voltage generator for reading a stored value from said storage circuit, converting the stored value to the electric signal, and delivering the electric signal,

wherein the electric signal delivered by said applied voltage generator is used as an input signal to said electromechanical transducer.

17. The filter according to claim 15, wherein said storage circuit is implemented by a digital circuit, and said applied voltage generator includes a digital/analog converter as a component thereof.

18. The filter according to claim 16, wherein said storage circuit is implemented by a digital circuit, and said applied voltage generator includes a digital/analog converter as a component thereof.

19. The filter according to claim 15, comprising a mechanism for applying an electric signal delivered by said applied voltage generator to said electromechanical transducer through a booster circuit or a voltage reduction circuit or an amplifier circuit.

20. The filter according to claim 16, comprising a mechanism for applying an electric signal delivered by said applied voltage generator to said electromechanical transducer through a booster circuit or a voltage reduction circuit or an amplifier circuit.

21. The filter according to claim 15, wherein said storage circuit and/or said applied voltage generator are partially or entirely formed on the same substrate as said substrate on which said acoustic wave resonator is formed.

22. The filter according to claim 16, wherein said storage circuit and/or said applied voltage generator are partially or entirely formed on the same substrate as said substrate on which said acoustic wave resonator is formed.

23. A composite filter comprising a plurality of the filters that are in parallel according to claim 1, said filters having changeable center frequency ranges different from one another.

24. A composite filter comprising a plurality of the filters that are in parallel according to claim 2, said filters having changeable center frequency ranges different from one another.

25. The composite filter according to claim 23, wherein an amplifier is connected in series to each of said filters.

26. The composite filter according to claim 24, wherein an amplifier is connected in series to each of said filters.

27. The composite filter according to claim 23, wherein said filters are separated from one another by an isolator.

28. The composite filter according to claim 24, wherein said filters are separated from one another by an isolator.

29. The composite filter according to claim 23, wherein a circulator is connected to a branch point for each of said filters.

30. The composite filter according to claim 24, wherein a circulator is connected to a branch point for each of said filters.

31. The composite filter according to claim 23, wherein a switch is connected in series to each of said filters.

32. The composite filter according to claim 24, wherein a switch is connected in series to each of said filters.

33. The composite filter according to claim 23, wherein a variable phase shifter is connected in series to each of said filters.

34. The composite filter according to claim 24, wherein a variable phase shifter is connected in series to each of said filters.

35. The composite filter according to claim 31, comprising a storage circuit for storing an on/off state of the switch connected in series with each filter in order to realize a combination of filters which provide desired frequency characteristics.

36. The composite filter according to claim 33, comprising a storage circuit for storing an adjustment value for the phase by the variable phase shifter connected in series to each filter for realizing a combination of filters which provide desired frequency characteristics.

37. The composite filter according to claim 23, wherein each of said filters is formed on the same substrate.

38. The composite filter according to claim 24, wherein each of said filters is formed on the same substrate.

39. The composite filter according to claim 35, wherein each of said

filters and all or part of devices connected to each of said filters are formed on the same substrate.

40. The composite filter according to claim 36, wherein each of said filters and all or part of devices connected to each of said filters are formed on the same substrate.

41. A filter assembly comprising the filter according to claim 1 hermetically sealed in a package.

42. A filter assembly comprising the composite filter according to claim 23 hermetically sealed in a package.

43. The filter assembly according to claim 41 including a gettering material disposed within the package.

44. The filter assembly according to claim 42 including a gettering material disposed within the package.

45. An integrated circuit chip comprising the filter according to claim 1 integrated on the same substrate as part of a circuit.

46. An integrated circuit chip comprising the composite filter according to claim 23 integrated on the same substrate as part of a circuit.

47. An electronic device containing the filter according to claim 1.

48. An electronic device containing the composite filter according to claim 23.

49. An electronic device containing the filter assembly according to claim 41.

50. An electronic device containing the integrated circuit chip according to claim 45.

51. A method of changing frequency characteristics of a filter, comprising the steps of:

applying the filter according to claim 1 with a first electric signal to mechanically deform said acoustic wave resonator to change the center frequency of said resonator; and,

applying the filter according to claim 1 with a second and a third electric signal to change a relative position of the input electrode to the acoustic wave resonator and to change a relative position of the output electrode to the acoustic wave resonator to change the external Q-value.

52. A method of changing frequency characteristics of a filter, comprising the steps of:

applying the filter according to claim 2 with one or a plurality of first electric signals to mechanically deform said acoustic wave resonator to change the center frequency of a plurality of resonance modes of the resonator unit;

applying the filter according to claim 2 with a second and a third electric

signal to change a relative position of the input electrode to the acoustic wave resonator and to change a relative position of the output electrode to the acoustic wave resonator to change the external Q-value; and applying the filter according to claim 2 with one or a plurality of fourth electric signals to deform each of a plurality of sites which provide coupling between the resonance modes of said resonator unit to change the coupling coefficient between the resonance modes.

53. A method of changing frequency characteristics of a filter, wherein in the filter according to claim 15, the storage circuit previously stores values corresponding to electric signals which realize the center frequency and the external Q-value of the resonator compatible with desired frequency characteristics, and the applied voltage generator, upon changing the frequency characteristics of the filter, reads the stored value from the storage circuit, and applies a formed electric signal to the electromechanical transducer of the filter to change the frequency characteristics of the filter.

54. A method of changing frequency characteristics of a filter, wherein in the filter according to claim 16, the storage circuit previously stores values corresponding to electric signals which realize the center frequency, the external Q-value, and the coupling coefficient between the resonance modes of the resonator compatible with desired frequency characteristics, and the applied voltage generator, upon changing the frequency characteristics of the filter, reads the stored value from the storage circuit, and applies a formed electric signal to the electromechanical transducer of the filter to change the frequency characteristics of the filter.

55. A method of changing frequency characteristics of the composite filter according to claim 23, comprising the step of changing the frequency characteristics of each filter to change the frequency characteristics of said composite filter.

56. A method of changing frequency characteristics of a composite filter, wherein in the composite filter according to claim 35, the switch connected in series to each filter is turned on/off to change the frequency characteristics of the composite filter in order to realize desired frequency characteristics.

57. A method of changing frequency characteristics of a composite filter, wherein in the composite filter according to claim 36, the phase is adjusted by the variable phase shifter connected in series to each filter to change the frequency characteristics of the composite filter in order to realize desired frequency characteristics.